Proposal of Elemental Task in the BFBT Benchmark

(DRAFT)

The theoretical void distribution in a sub-channel is determined from following effects.

- Mass flow quality and slip between phases
- Cross-flow between sub-channels

The measured data includes above two effects and measurement error.

Task-1 Classical void-quality relation

In order to remove the concern regarding the cross-flow effect from, calculate a void fraction in the elemental sub-channel or the heated single tube (the equivalent tube) which has a same thermal diameter as the elemental sub-channel shown in Fig. 1. The analyzed void fraction (α_{tube}) will be plotted against the equilibrium quality. Also, other key result, such as the axial profile of the flow regime and the velocity of each phase, would be evaluated. Code to code benchmark will be carried out, if necessary. The reference void-quality relation will then be defined by the benchmark team.

(a)Elemental sub-channel (b)Equivalent tube

Fig. 1 Channel Geometry

Task-2 Cross-flow effects on void fraction

A void fraction in a sub-channel may be separated as,

$$\alpha_{Sub} = \alpha_x + \alpha_{CF}$$

where,

α_{Sub} : Void fraction in sub-channel

α_x : Void fraction due to quality and slip

α_{CF} : Void fraction due to cross-flow

We may assume α_x shall be calculated with the equivalent tube. Then,

$\alpha_x = \alpha_{tube}$ with adjustment by the bundle equilibrium quality.

Then, we obtain

$\alpha_{CF} = \alpha_{Sub} - \alpha_{tube}$ with adjustment by the bundle equilibrium quality.

In order to focus on the cross-flow effect, the value α_{CF} shall be placed on the table as follows:

For the analytical point in Exercise I-1, the reference α_{CF} in each sub-channel will be provided by the benchmark team based on the data, which includes experimental error.

Participants also evaluate α_{CF} in each sub-channel based on their analysis.

Then, a deviation of α_{CF} between the analyzed quality point (5%, 12% and 24%) will be taken for each sub-channel. Based on the deviation, the experimental bias may be reduced.

Code to data benchmark on such α_{CF} will be carried out. And, we may derive some empirical correlation on α_{CF}, if necessary using data other than the exercise point.

Task-3 Critical power in single channel

In order to make a simple prediction on critical power without the cross-flow etc., calculate a critical power in the elemental sub-channel or the heated single tube with a given inlet flow condition. Possibly a spacer would be eliminated from the calculation.

A code to code benchmark on the calculated critical power will be carried out. If necessary, some other critical power experiment with a single tube would be used as a reference.

Remark on the experimental bias

There exist duplicated experimental points in the void distribution measurement. Comparison of the measured void fraction data in each sub-channel between the measurements will give us some information. The bias may common between the measurements. If such a comparison is performed, still some randomness is expected to appear.

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